

DRAFT

Blue River Turbidity Report

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EXECUTIVE SUMMARY

The federal Clean Water Act requires that each state assess the quality of surface waters within their jurisdiction and develop a list consisting of their surface waterbodies that do not comply with state water quality standards. The resulting list is designated as the state's Water Quality Limited Waters List or the **303(d) list**. The resulting list of waterbodies that do not comply with water quality standards must be re-evaluated and updated by each state every two years. However, once a waterbody is listed on a state's 303(d) list, the state must address the water quality issues responsible for that listing.

For some waterbodies, implementation of site specific management practices within the watershed encompassing the 303(d) listed waterbody will be sufficient to return the waterbody to compliance with state surface water quality standards. In such cases, when a listed waterbody is demonstrated to comply with state water quality standards a request by the state to the United States Environmental Protection Agency (USEPA) to delist that specific waterbody from the state's 303(d) list is appropriate. However, for 303(d) listed waterbodies that have been subject to multiple and or a complex mix of discharging activities, it may be necessary to perform a Total Maximum Daily Load (**TMDL**) analysis. The TMDL approach, allocates and limits pollutant loadings from specific discharging activities to a specific 303(d) listed waterbody with the goal of bringing the noncomplying reaches of the waterbody into compliance with water quality standards. Regardless of the approach the end result of either management practice implementation or TMDL analysis is to bring a waterbody from noncompliance to compliance with water quality standards.

With this report the Arizona Department of Environmental Quality (ADEQ) is requesting USEPA remove the Blue River, from KP Creek to the confluence with the San Francisco River from the list of Arizona's Water Quality Limited (303[d]) waters. This request is supported by the following.

1. Results of water quality monitoring in WY 2000 and 2001 indicate that the Lower Blue River is in compliance with applicable state Water Quality standards for turbidity and has been in compliance for the past 10 years.
2. Water Quality Standards were only exceeded on two occasions in the ten year sampling record. The sample responsible for the partial attainment listing of the LBR as reported in the state's water quality assessment report was collected during high flows following storm event which resulted in the destruction of the USGS monitoring station located at site 14 south of Juan Miller Campground Road. The second sample was erroneously collected.
3. The geology of the Blue River Watershed (BRW) is extremely unstable as

evidenced by the large number of landslides which vary in size from a few acres to over 5000 acres in size. As a result, the watershed has a high to extreme potential to produce sediment from natural conditions.

4. Arizona's applicable surface water quality standard for turbidity within Arizona Water Quality Standards (AAC, Title 18, Chapter 11) is being redefined by rule. When approved in early 2002, the beneficial use for the Lower Blue River will change to A&Ww. The new water quality standard for turbidity associated with this designation will be 50 NTUs.
5. The upper half of the Lower Blue River Watershed is within southern half of the Blue Range Primitive Area which was established in 1967. This area and has been subject to few if any impacts attributable to human activity for the past 35 years.
6. Commitment of the Apache Sitgreaves National Forests (A-S) to implement additional land management actions to address connected disturbed areas. In addition, the Forest Service is committed to continue critical management of all range allotments within the watershed and to riparian restoration activities as recommended by the multi-agency National Riparian Service Team (NRST).

The A-S and the ADEQ are committed to partnering efforts to ensure that the Blue River remains clean. These efforts include the continuing implementation of planned watershed management efforts, implementation of Best Management Practices for nonpoint source activities and critical placement of water quality projects. Priority efforts for reduction of sediment discharges from human induced activities will focus upon connected disturbed areas associated with roads, support of projects on private lands adjacent to the Blue River and critical management of livestock and wildlife grazing activities within the watershed.

BACKGROUND INFORMATION

Geography

The BRW is located along Arizona's eastern border and extends into New Mexico in several locations. The watershed encompasses approximately 400,000 acres and has recently been subdivided into two 200,000 acre fifth code watersheds, the Upper Blue River and Lower Blue River Watersheds, by the USDA Natural Resource Conservation Service (9) (Figure 1). A little more than 22,000 acres of the UBRW are located in Catron County of New Mexico. Approximately 55% of the total watershed has been classed as Primitive Area since 1964. More than 99% of the Blue River watershed is public land under the management authority of the US Forest Service Apache Sitgreaves National Forests (Figure 2).

The northern extent of the BRW is in Apache County, Arizona. However, most of the BRW lies within Greenlee County, Arizona. The northern latitude is 33° 50' 00" and the southern latitude is 33° 10' 00". The eastern longitude is 108° 58' 00" and the western longitude is 109° 25' 00". The community of Alpine, Arizona is just above the northern BRW boundary. To the west of the southern BRW boundary are the communities of Clifton and Morenci. Arizona state highway 191 bounds most of the BRW on the west (Figure 2).

The entire 40 mile reach of Blue River from the New Mexico border to the confluence with the San Francisco River is perennial. In addition, several waterbodies that are tributary to the Blue River are also perennial along some of their length. These include the Campbell Blue, Turkey Creek, Jackson Creek, Foot Creek, Grant Creek, KP Creek, Lanphier Canyon, Raspberry Creek, Strayhorse Creek, Little Blue Creek, Squaw Creek and Pigeon Creek (Figure 2).

The area of the Blue River encompassed by the UBRW and LBRW extends from the Arizona/New Mexico border in the north to the confluence of the Blue River and San Francisco River on the south. The UBRW (15040004-26) includes that portion of the Blue River drainage extending from the AZ/NM state border to just below Raspberry Creek. The southern LBRW (15040004-25) extends south from the boundary line at Raspberry Creek to the confluence of the Blue and San Francisco Rivers (Figure 1).

The BRW is extremely rugged and varies from a mountainous area in the northwest to steep walled gorges and open canyons in the south. As a result, vegetation communities are highly variable with pine and fir communities at the highest elevations and desert scrub communities at the lowest elevations.

Climate

The BRW is located in the southern portion of the northeast climatological division and the northeastern portion of the Southeast climatological division of Arizona. The climate is highly variable as a consequence of the uneven topography and wide range in elevation varying from hot steppe at the lower elevations to boreal at the higher elevations (6). Elevation ranges from a low of about 3300 feet near Clifton to a high of about 9000 feet on the peaks near Alpine, Arizona.

The average annual precipitation ranges from 12 inches to over 120 inches. Precipitation distribution is bimodal with the wettest season occurring during the summer monsoon months of July to October. A second wet season extends from December through March. Mean annual snowfall ranges from 20 to more than 60 inches; however, at lower elevations, snowfall does not persist for more than a few days. Average annual temperatures range from 85EF at the lower elevations to less than 32EF at the higher elevations. The freeze free period ranges from approximately 180 days at the lowest elevations to less than 60 days at the highest elevations (6).

Geology

Tertiary volcanics are the predominant rock type within the BRW. Basalts, andesites, rhyolitic tuffs, and ash characterize the volcanics present. Lahars, volcanic debris flows, have been identified. Sedimentary units, such as the Gila conglomerate, and colluvium and alluvium typify the Quaternary materials present. Erosional discontinuities exist between the Tertiary volcanics and Quaternary sedimentary units. A minor amount of scattered limestone clasts have been noted.

The BRW is located within an area which has undergone Basin and Range type extension. Normal faults or horst and graben structures, as exhibited in the upper portion of the Campbell Blue drainage, are evidence of this extension. It is possible that the mainstem of the Blue River is controlled by a graben fault (4). Shear zones are also present.

The unstable nature of geologic units within the BRW is evidenced by an extremely large number of landslides which vary from only a few acres to more than 5000 acres in size (Figure 3). Mass movement occurs because of the following factors:

1. the steep and rugged volcanic rock terrain;
2. incompetent beds (volcanics with bentonite interlayers);
3. water in the form of snow and rain, surface water flows, and groundwater
4. a significant presence of structural controls, such as faults and/or joints;
and,
5. denuded hillsides (a result of previous mass movement events and, in certain areas, livestock grazing).

Three slide types have been identified within the BRW (4). These include the following:

1. debris slides in which the slope failure results in all the failed material being evacuated from the site;
2. earth flows in which a low sloping failure with no apparent head scarp is apparent; and,
3. deep seated slides that have a deep failure plane, a remnant failed mass and a visible head scarp or source area.

The BRW has a high to extreme rate of sediment production from the following natural sources:

1. historic and current mass movement sites (which have been destabilized, rubblized, and denuded);
2. alluvial deposits; and,
3. stored channel deposits (point bars and old terraces).

The BRW is extremely rugged and varies from a mountainous area in the northwest to steep walled gorges and open canyons in the south. The watershed has a high to extreme rate of sediment production from the following sources: landslides and resultant denuded slopes, slope deposits, and stored channel deposits (point bars and old terraces). The terrain within this watershed is capable of producing more sediment than the flushing flows of the river, streams, and creeks within the watershed can transport. Within the BRW landslide deposits and raw un-vegetated slope faces are the primary sources of sediment and account for most of the materials responsible for elevated turbidity measured in the water column. Inman has concluded that anthropogenic sources such as roads, site development, livestock grazing, and logging are only minor contributors to the sediment budget in the BRW (4). However, the evaluation of the Blue River in 2000 by the multi-agency National Riparian Service Team indicated that sediment attributable to roads, while only a minor fraction of the total sediment load, is the most important source due to its impact upon aquatic environments and aquatic life forms (Appendix A). Their conclusion is based upon the finding that the particle size discharged from road surfaces have high probability for lodging in the void spaces between streambed cobbles and gravels during low flow events, thereby denying these habitat sites to aquatic life forms.

Normal faulting or high angle vertical faults predominate throughout the watershed. There are some areas within the watershed where these faults form shear zones: e.g. wide fault swaths where most of the material in the zone has been rubblized. In addition, the watershed has many features that appear to be fault block or graben structures as exhibited in the upper portion of the Campbell Blue drainage. These areas are distinguished by high escarpments which demonstrate a high degree of linearity. It is also possible that the mainstem of the Blue River is also controlled by a graben fault (4).

Large areas within the watershed are characterized by having more resistant rock types overlying ash deposits. When these ash materials weather, the expansive clay material bentonite is formed. Bentonite has great water holding capacity and when wet becomes very slick. The bentonite material is a principle factor in facilitating slope failures particularly in areas identified to contain nested slide complexes. Once a landslide has formed, the failed material has a much greater ability to hold moisture over longer periods of time than the adjoining non-failed material. Landslides within this watershed can also result when the mass of material exceeds the restraining forces. The restraining force is usually provided by the toe area of the slide. These materials act as a buttress. However, when the buttressing material is eroded by a flowing stream, mass wasting or failure occurs (Figure 4) (4).

History

In 1922, Aldo Leopold characterized the condition of the Blue River as “ruined” in his paper, Erosion As a Menace to the Social and Economic Future of the Southwest, which he presented to the New Mexico Association for Science (5). His paper noted that significant changes in stream morphology and riparian community had occurred as a result of the removal of large wood from the riverine system at the turn of the century to facilitate the floating of log rafts to the mines near Clifton and Morenci. Since Leopold’s early characterization of the BRW, erosion and the contribution of sediment to the Blue River has been of increasing concern. During the early-mid 1990’s, on-going cooperative water quality sampling and watershed assessment studies have been conducted under the authority of an Intergovernmental Agreement finalized between the ADEQ and the USFS Southwest Regional Office in 1990. The results of these efforts indicated that turbidity measurements were occasionally exceeding the established water quality standard (1). Since that time, the Apache Sitgreaves National Forests has made significant efforts to manage potential land disturbing activities on Forest Service Lands. These actions have included:

- critical review of allotment permits and intensified monitoring of range condition;
- significant reductions in the numbers of livestock upon allotments not complying with required resource management goals;
- restricted timber harvest operations within the watershed;
- partnering efforts with Greenlee county to improve road maintenance and crossings; and
- improvement, closures and obliteration of inventoried roads that do not meet resource goals.

Positive reductions in soil erosion and contributions of sediment from human activities conducted within the watershed to the Blue River and its tributaries have been made. In response to the growing concern over potential sediment discharges from facilities and activities conducted within the BRW, the ADEQ and the USFS A-S initiated a

collaborative study to identify and characterize potential sources of sediment that could with reasonable probability, contribute pollutants into the Blue River and/or its tributaries. The resulting inventories of sources were prioritized and assembled into an implementation plan for project development and watershed implementation as resources became available. In 1986, the A-S completed the field work for the Terrestrial Ecosystems Survey (TES) of the Apache Sitgreaves National Forests (6). The soil characterization and vegetation data resulting from their field investigations were incorporated into the final TES report and have been utilized in evaluations of grazing allotment reviews since the early 1990's (3). In addition, the A-S completed an inventory of connected disturbed areas (CDAs) in the summer of 2001. These have been defined as areas of high runoff potential and include roads, construction sites, trails, and un-vegetated sites that have probability of discharging sediment laden runoff into streams or lakes.

In 2000, the ADEQ and the A-S partnered to develop a terrain analysis (TA) of the BRW (4). The conclusions from the TA have been used to support A-S efforts to implement the USFS policy on Roads Analysis Process in all National Forests and for facilitating implementation of the USDA FS and the United States Department of Interior Bureau of Land Management (BLM) 1998 framework for Analyzing the Hydrologic Condition of Watersheds (HCA) (7). In support of the HCA effort conducted by the A-S, the USFS Region 3 Office conducted T-walk (Thalweg Watershed Area Link) analyses of the Blue River between FR 232 and Blue Camp, and on limited reaches of Grant Creek, KP Creek, and Lanphier Canyon in August 2000 (Figure 5). In addition, in October 2000, the multi-agency NRST conducted a field analysis of the condition of riparian habitats on the Blue River from the NM border to its confluence with the San Francisco River. The NRST final report containing their recommendations for restoration of riparian communities within the Blue River Watershed has a proposed early 2002 release date. However, draft recommendations which were released for comment in May 2001 have been used in support of the proposed implementation plan reported in this document (Appendix A) .

Arizona has proposed to amend the state's water quality turbidity standard to include a 5000 foot elevation criterion for differentiating Aquatic and Wildlife cold (A&Wc) from Aquatic and Wildlife warm (A&Ww). The reclassification of beneficial uses from A& Wc to A&Ww was introduced during the 1998 triennial review of Arizona's surface water quality standards and would increase the applicable turbidity standard for the Blue River in the LBRW (15040004-025) from 10 NTUs to 50 NTUs for those areas below the designated 5000 foot elevation level. The ADEQ anticipates that the proposed change to the current surface water quality standards will be approved by the USEPA in 2002. Prior to the proposed rule change, the Blue River was listed as fully attaining in the Upper Blue River Watershed from the NM border to KP Creek and partially attaining for turbidity in the Lower Blue River Watershed from KP Creek to the San Francisco River. However, only one storm event sample collected in the LBRW over the past 10 years has exceeded the current existing A&Wc 10 NTU standard. Regardless of whether the new rule to

amend the State of Arizona's turbidity standard is approved, the LBR is and has been in substantial compliance with the existing surface water quality standards for a decade and should therefore be removed from the 303 (d) list.

The proposed re-designation of the LBR as fully attaining of the current turbidity standard is also consistent with watershed condition since the LBRW occupies a geographic area that is largely designated as a Primitive Area in which land disturbing activities are not permitted. The ADEQ and USFS A-S conducted joint water quality monitoring for the Blue River in WY 2001. The results of these water quality monitoring efforts indicate that the Blue River is fully supporting of its designated uses from its northern extent at the Arizona/New Mexico border to its confluence with the San Francisco River (Appendix B).

LAND USE

There is one National Pollution Discharge Elimination Systems (NPDES) permitted facility located in the UBRW. This facility is a salmonid aquaculture fish farm in which water from the Blue River is diverted, flows through the facility and is subsequently returned to the river. All other stressors discharged from sites or activities that have potential to degrade water quality in the UBRW are associated with either natural conditions or nonpoint source (NPS) activities. The northern extent of the Blue Range Primitive Area includes the area that extends from Bush Creek to the divide between the UBRW and LBRW at Raspberry Creek. There are 7 historic in-holdings and a USFS campground located adjacent to the Blue River in that portion of the Blue Range Primitive Area located in the UBRW. In the past 100 years, the UBRW has been subject to the following NPS activities: livestock grazing, timber harvests, wildfires, home construction, septic disposal, road building and maintenance, resource extraction, recreation and wildlife management. Considering the past historic land use practices, the geologic and climatologic setting of the UBRW, it is easy to understand that the principal stressors that have potential to negatively impact the water quality within the UBRW include sediment, fecal coliform, *Escherichia coli*, nutrients, and heavy metals.

There are no NPDES permitted facilities located in the LBRW and only 3 small historic in-holdings of private land. At its northern extent, almost 50% of the total acreage of the LBRW is encompassed by the Blue Range Primitive Area. As a result, this area is subject to only natural conditions and limited NPS activities which have included: livestock grazing, timber harvests, wildfires, road building and maintenance, resource extraction, recreation, and wildlife management. The principal stressor that has potential to impact water quality within the LBW is sediment derived from past activities and the one road that services two ranch headquarters and the Juan Miller Campground.

IDENTIFICATION OF POLLUTANT SOURCES

The pollution source assessment for both the UBRW and LBRW has been coordinated

with the ecosystem management staff and watershed management program field personnel at the USFS A-S as a partnering effort authorized under the conditions of the 1990 Intergovernmental Agreement between the ADEQ and the US Forest Service Southwestern Region (Appendix B). The BRW assessment effort utilized on the ground experience from USFS A-S field resource specialists, data and field reports gathered by the multi-agency NRST, 30 meter multi-band satellite imagery and IRS-1C 5 meter color satellite imagery in coordinating initial evaluations, field ground truthing, geomorphology studies and identifying sites for watershed restoration implementation activities to minimize sediment discharges. The 5 meter satellite imagery was particularly useful in facilitating the ADEQ and A-S watershed and ecosystem resource management staff decision processes in rapidly identifying areas of degradation, scoping projects to address discharges, and to develop and coordinated implementation efforts. The coordinated effort supported by 30 meter and 5 meter satellite imagery facilitated effective assessment to rapidly identify:

- C source categories;
- C location of sources within the watershed;
- C magnitudes of loading from identified sources;
- C pollutant transport mechanism(s); and
- C frequency and duration of pollutant loading.

Point Source Activities

The only point source permitted activity within the BRW is the previously mentioned salmonid aquaculture facility in Blue, Arizona. On-going water quality monitoring efforts have indicate that the facility is not discharging in excess of permit requirements and that the Blue River above and below the facility is in full support of the state surface water quality turbidity standard.

Nonpoint Source Activities

The Blue River watershed has a high to extreme potential for discharge of sediment from natural sources. These include landslides, slope deposits and stored channel deposits (point bars and old terraces). The terrain within the BRW is capable of producing more sediment than the flushing flows of the river and tributary streams and creeks can transport. Landslide deposits and failed raw un-vegetated slope faces are the primary sources of sediment within this watershed and account for most of the materials responsible for the few elevated turbidity values measured in the water column. Anthropogenic sources such as roads, site development, livestock grazing and logging are only minor contributors to the sediment budget in the BRW (5). However, the evaluation of the Blue River in 2000 by the multi-agency NRST indicated that the sediment attributable to roads, while a minor fraction of the total sediment load, is the most important source due to its to impact upon aquatic habitats and aquatic life forms

(Appendix A). Their conclusion is based upon the finding that the particle sizes discharged from road surfaces have a high probability for lodging in the spaces between streambed cobbles and gravels during low flow events and thereby denying these habitat sites to aquatic life forms. As a result of their recommendations, the USFS A-S completed an inventory of connected disturbed areas (CDAs) within the BRW during the summer of 2001. The A-S is currently evaluating the identified CDAs and prioritizing specific CDAs that have a high probability of yielding positive responses to project implementation and restoration activities.

Waterbody Turbidity-Linkage To Water Quality and Water Quality Standards

Turbidity, which is a measure of the refraction of light as it passes through a sample of water, is due to scattering of photons by suspended particulate material. Light scattering within any given water quality sample may be associated with a variety of causes such as micro-organisms or colloidal soil particles. The turbidity standard was adopted as an indirect method of measuring water quality to protect aquatic life forms from excessive habitat degradation due to sedimentation or algal blooms. Since turbidity is a dimensionless unit, it is not readily converted into quantitative units.

Arizona has proposed to amend the state's water quality turbidity standard to include a 5000 foot elevation criterion for differentiating A&Wc from A&Ww. The current statewide turbidity standard of 10 NTUs would be amended with areas above 5000 foot being designated as A&Wc whereas surface waters below 5000 foot elevation would be designated as A&Ww. The current statewide standard of 10 NTU's would continue to apply only to surface waters designated as A&Wc. However, a new standard of 50 NTU's would apply to A&Ww which would be located below the 5000 foot elevation criterion. The ADEQ anticipates that the proposed change to the current surface water quality standards will be approved by the USEPA in 2002.

Water Quality

Beneficial Use Designations

ADEQ codifies water quality regulations in Title 18, Chapter 11 of the Arizona Administrative Code (A.A.C.). Designated beneficial uses, such as fish consumption, recreation, agriculture, and aquatic biota are described in Section R18-11-104 of the A.A.C. and are listed for specific surface waters in Appendix B of A.A.C. R18-11. The Blue River is currently protected along the listed reach 15040004-025 in the LBRW for the following designated uses:

- Aquatic and Wildlife, cold water fishery (A&Wc)
- Fish Consumption (FC)
- Full Body Contact (FBC)

- Agricultural Irrigation (AgI)
- Agricultural Livestock Watering (AgL)

The unlisted UBRW reach 15040004-026 is also currently protected with the same designated uses and standard values.

303(d) Listing Data

As previously mentioned, surface water quality standards are adopted by states to maintain and restore the nation's waters for designated beneficial uses. The 1998 listing of the lower reach of the Blue River (HUC 15040004-025) for turbidity was based on samples collected by the ADEQ from Water Years (WY) 1992 through 1996. Of these samples, four biocriteria reference samples were interpreted as indicating that the reach to be in "full support" with an exceptional macroinvertebrate community. From 1995 to 1999, the ADEQ collected an additional 19 samples (ADEQ, 305(b) Report, 2000). Of these only one sample collected during a severe storm event exceeded the 10 NTU water quality standard. In addition, assessments of the macroinvertebrate community for the 15040004-25 LBRW reach also indicated that turbidity was not impairing the A&Wc uses.

The HUC 15040004-026 reach, which extends from the New Mexico border to KP Creek, was reported in the 2000 305(b) Report as "partially attaining". Four water quality turbidity samples were collected by the ADEQ over the period of WY 1992 to 1996 and an additional 4 samples were collected from WY 1997 to 2000. One storm event sample exceeded the A&Wc turbidity standard of 10 NTU. As a result the reach 15040004-026 in the UBRW was assessed as in "partial support" but was not listed in the 1998 303(d) list due to inadequate numbers of water quality samples and exceptional macroinvertebrate community.

SAMPLING EFFORT

In May of 2001, the ADEQ and USFS A-S committed resources to complete a water quality monitoring study to clarify the issue of turbidity impairment on the Blue River. The cooperative effort involved four sampling trips to each of 15 sites in this remote watershed. Eleven of the 15 sites were located on the Blue River. Four sites were located along the Campbell Blue River (CBR) west of the confluence of the BR, Dry Blue (DB) at the Arizona/New Mexico border. These same sites were sampled on all trips (Figure 6). The data resulting from the WY 2001 joint sampling effort are reported in Table1 and in Appendix D.

The WY 2001 data and the data collected from 1992 thru 2000 were analyzed as one data set. Interpretation of the results from the WY 2001 monitoring data and previous data indicate that the reaches HUC 15040004-025 and HUC 15040004-025 of the Blue River

TABLE 1. BRW Turbidity Samplings WY 2001

Waterbody	No. Samples	No.< 10 NTU	No. > 10 NTU
Lower Blue	7	7	0
Upper Blue	36	34	2
Campbell Blue	16	16	0

are in compliance with Arizona's water quality turbidity standards. The lower reach 15040004-025 of the Blue River from KP Creek to the San Francisco River should be delisted as the data gathered and reviewed demonstrate that the surface water quality of the BR is exceptional (Table 2 and Appendix D).

TABLE 2. BRW Turbidity Samplings 1992-2001

Waterbody	No.Samples	No.<10 NTU	No.< 10 NTU
Lower Blue	44	43	1
Upper Blue	45	42	3
Campbell Blue	16	16	0

Sampling Site Selection

Sampling sites were collaboratively selected based upon most probable sites for sediment contribution to the Blue River from anthropogenic and natural sources. The USFS A-S hydrologist and riparian systems specialists inventoried eastern Arizona streams in the A-S National Forests for a suitable match for geography, geology, hydrology and channel morphology to the Upper Blue River to identify a possible site that was subject to minimal anthropogenic influences for use for a background site. It was determined that there were no other rivers/streams within the A-S forests that could be used as a possible background site. As a result, it was determined that the Fritz Ranch sampling site within the LBRW, located immediately below the designated Primitive Area and above the Juan Miller Campground Road could be used as the background site for this study. Neither the upstream Sandrock or the surrounding Fritz grazing allotments have been subject to grazing activities in the past decade.

Seasonal Variations

Flow data from the USGS gauge station located in the Lower Blue River watershed below

Juan Miller Campground road was averaged for each month for the period of 1992 to 2001. These values indicate that observed variations in seasonal flows in the Blue River system are attributed to the bimodal discharges from spring season snow melt and summer monsoon rains.

Sampling Data

Sampling data and graphs are reported in Appendix D.

IMPLEMENTATION PLAN

Although the results of the BRW cooperative water quality monitoring effort has conclusively demonstrated that the BR should be delisted, the partners involved this effort are committed to keeping the waters of the Blue River clean. As a result, the Blue River Turbidity Minimization Implementation plan integrates ongoing efforts of the USFS A-S, Greenlee County, US Fish and Wildlife, ADEQ and private land owners within the BRW. Proposed future projects and activities to achieve water quality goals will be integrated into the cooperative watershed plans as resources are available and as projects are approved and funded. In this respect, the Blue River turbidity project is utilizing a phased approach with implementation activities occurring as partnering resources become available. This implementation strategy is consistent with the US EPA guidance delineated in publication EPA 841-B-99-004. It is anticipated that the overall time frame for implementation within the BRW will be 10-20 years. A principal constraint for implementing watershed improvement activities within the BRW are the private lands in-holdings and the continuing restriction placed upon matching federal funding with federal funding available through grants administered by the USEPA. The overall effect of the fed-fed funding restriction for water quality and watershed improvement activities is to delay water quality improvement implementation time lines by several decades.

Best Management Practices (BMPs)

The Arizona Environmental Quality Act (EQA) defines BMPs “as the methods, measures, or practices to prevent or reduce pollutant loading discharges and include structural and nonstructural controls and operations and maintenance procedures”(A.R.S.§49-201.3). Outside of statute, BMPs are referenced as commonly used, state of the art, management practices and or structures that have probabilities of reducing pollutant loading discharges from nonpoint source activities. Implementation of voluntary BMPs has been required for grazing activities since 1999 (ARS §49-202.01).

Grazing Management Plans are evaluated by ADEQ upon request for federal allotment permit renewals, between permit renewal cycles as resources permit, and whenever water quality monitoring results indicate that review may be necessary. The A-S and Greenlee County have partnered and will continue to partner in developing and implementing

BMPs for county road maintenance and minimization of sediment discharges from identified CDAs. These areas have been defined as high runoff areas like roads and other disturbed sites that discharge surface runoff into streams or lakes (USFS Road Policy). Each project will include a monitoring component that evaluates the relative pollutant potentials for adversely impacting macro-invertebrate communities. Management practices will be incorporated into project plans to ensure that critical loss of “void space” attributable to bed load filling of spaces between gravels and cobbles will not occur. The relative health of the macro-invertebrate community will be annually assessed to develop and maintain a record of an Index on Biological Integrity (IBI). The incorporation of Arizona Game and Fish Department, and the US Fish and Wildlife Service for endangered fish species issues into the BRW project has provide additional resources in the form of direct project funding and acceptable match for additional federal grant funding

National Riparian Service Team Recommendations

Despite historic abuses that resulted in an almost complete de-stabilization of the Blue River, there is current evidence that significant recovery, particularly on Forest Service administered lands is occurring (Appendix A). The 2001 recommendations of the NRST include the following:

- implement management practices that minimize discharge of fine sediment from roads into nearby waterbodies;
- minimize road repair and maintenance activities that remove riparian vegetation or inhibit riparian vegetation from being established;
- reduce road density where possible;
- implement BMPs to protect riparian communities from foot and horse traffic;
- implement BMPs to protect riparian communities from grazing activities of both wild and domestic grazing ungulates;
- implement timber management strategies that return large wood to waterbodies within the BRW; and
- reduce the competitive impact of non-native aquatic species upon native species within the BRW.

Monitoring

The ADEQ and the USFS A-S will continue to cooperatively monitor and document water quality parameters, stream morphology, watershed and riparian community

condition over the next decade. Resource allocation has been prioritized for the following areas:

- critical evaluation of livestock grazing numbers for permitted allotments within the watershed will continue; and
- extensive evaluation of roads within the watershed to address critical CDAs on a project by project basis.

USFS and County Roads

During the summer of 2001 the A-S initiated a comprehensive inventory of highway, unsurfaced level 1, level 2, level 3 Forest Roads(FR), currently open FR associated with prior timber sales and foot an horseback trails within the BRW. Roads classed as:

- level 1 are not regularly maintained and only appropriate for vehicles equipped with 4x4 capabilities;
- level 2 are dirt or native surfaces which receive infrequent maintenance; and
- level 3 are dirt or gravel surfaced roads that are regularly maintained to ensure passage by conventional 2x2 passenger vehicles.

The 2001 inventory summarized the condition of level 1-3 FR within the BRW as reported in Table 3.

Table 3. Forest Road-CDA Information

Forest Road	Segment Name	Length	% Connected to Disturbed Area
FR 281	Blue Rd	30.4 miles	60%
FR 567	Red Hill Rd	11.9 miles	50%
FR 30	Campbell Blue Rd	2.8 miles	26%
FR 232	Pueblo Park Rd	4.7 miles	53%
FR 475	Juan Miller Rd	13.6 miles	80%

The USFS A-S and Greenlee County have and continue to partner to minimize sediment discharges from the aforementioned FRs. During the fall of 2001, the USFS A-S will prioritize identified FR areas designated as Connected Disturbed for site specific BMP treatments and collaborative remedial project development. Site specific project

implementation will occur as resources become available. In addition, the USFS A-S will continue inventorying the 314 miles of foot and horse trails and more than 400 miles of FRs associated with historic timber sales during 2002.

Grazing Allotments

Although all or part of 23 permitted grazing allotments are encompassed by the BRW, resource conditions within 19 allotments have undergone critical environmental review since 1996. As a result of the current A-S allotment review process, a balance between watershed condition and domestic livestock forage utilization has been established. Watershed and rangeland specialists at the A-S included forage utilization limits within the terms and conditions of permit renewals and monitor forage on all allotments during permitted grazing periods. Permit conditions require that when utilization limits are reached on any given allotment, all domestic grazing animals must be removed from that allotment. These efforts have significantly minimized sediment discharge from grazing lands within the watershed into both tributaries and the main channel of the Blue River. Non-use along much of the riparian corridor of Blue River over the past decade has resulted in significant levels of riparian habitat recovery on publically administered lands.

Wildlife

Although water quality impacts attributable to livestock grazing activities have been significantly minimized through critical management of livestock and the allotment review process, ungulate wildlife populations have been largely un-managed. The increases in numbers of large wildlife ungulates, principally elk, is a major concern to resource managers attempting to balance water quality and activity impacts within the watershed. Reduction in numbers of grazing domestic livestock are being offset in many areas by increased uncontrolled populations of large grazing ungulate wildlife. Low population numbers of predatory species feeding upon wildlife and efforts to reduce natural winter kill by establishment of wildlife feeding stations, threatens to unravel the short terms gains achieved through critical management of domestic livestock within the BRW.

Activities on Private Lands

The USFS A-S does not have management authority for activities occurring on the limited number of private in-holdings within the BRW. However, these in-holdings located in close proximity to the Blue River have significant potentials for contributing sediment loads and adversely affecting water quality. Private landholders within the watershed have been contacted by members of the watershed staff at the A-S and technical field representatives from the NRCS to participate in the process to address surface water quality and watershed restoration. The NRCS has committed to assisting private landowners within the watershed with project implementation efforts designed to

reduce runoff and minimize sediment discharges from private property to the Blue River. Principal NPS activities on private lands that have potentials to adversely impact the Blue River include: livestock corrals, pasture lands, septic leachate, and bare compacted soils associated with homes and roads.

PUBLIC PARTICIPATION

A public meeting was hosted by the USFS A-S at the USFS Supervisor's Office in Springerville Arizona on May 1 and May 2, 2001 during the data gathering phase of this cooperative effort. Stakeholders invited to public meetings included private land holders living within the BRW, Grazing Allotment permittees, representatives from Greenlee County, USFWL, NRCS, and ADEQ. Presentations were made and comments accepted by stakeholders on the draft results of the NRST report, and draft Blue River Turbidity Report.

LIST OF ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
A-S	Apache Sitgreaves National Forests
A&Wc	Aquatic and Wildlife Cold
A&Ww	Aquatic and Wildlife Warm
BMP	Best Management Practices
BRW	Blue River Watershed
CDA	Connected Disturbed Areas
FR	Forest Road
HCA	Hydrologic Condition Analysis
IBI	Index of Biological Integrity
LBRW	Lower Blue River Watershed
NPDES	National Pollution Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
NRST	National Riparian Service Team
NTU	Nephelometric Turbidity Unit
TA	Terrain Analysis
TES	Terrestrial Ecosystem Survey
TSS	Total Suspended Solids
T-walk	Thalweg Watershed Area Link
UBRW	Upper Blue River Watershed
USDA	United States Department of Agriculture
USFS	US Forest Service
USFWL	US Fish and Wildlife Service

REFERENCES

1. Arizona Department of Environmental Quality, 1998. Arizona Water Quality Assessment EQR-98-14.
2. Arizona Department of Environmental Quality, 1998. Arizona's Water Quality Limited Waters List (Arizona's 303(d) List) EQR-98-8.
3. Arizona Department of Environmental Quality and US Department of Agriculture, Forest Service, Southwest Region, Intergovernmental Agreement, 1990.
4. Inman, D. E. 2000. United States Forest Service Region 3 Office unpublished report. Blue River Terrain Analysis.
5. Leopold, A. 1922. New Mexico Association for Science. *Erosion As a Menace to the Social and Economic Future of the Southwest*.
6. Laing, L., Ambos, N., Subirge, T., McDonald, C., Nelson, C. and Robbie, W., 1986.
USDA Apache Sitgreaves National Forests, *Terrestrial Ecosystems, Survey of the Apache Sitgreaves National Forests*.
7. McCammon, B., Rector, J., Gebhardt, K., 1998. USDA Forest Service and USDI Bureau of Land Management, *A Framework for Analyzing the Hydrologic Condition of Watersheds*.
8. Ratte, J.C., Landis, R. E., and Gaskill, D. L., 1969. USDI Geological Survey Bulletin 1261-E. *Mineral Resources of the Blue Range Primitive Area Greenlee County, Arizona and Catron County, New Mexico*.
9. USDA Natural Resource Conservation Service, 2001. *Federal Standards for Delineation of Hydrologic Unit Boundaries*.
[HTTP://www.ftw.nrcs.usda.gov/huc_data.html](http://www.ftw.nrcs.usda.gov/huc_data.html)

Appendix A

National Riparian Service Team, 2000
Condition of Riparian Habitats within the Blue River Watershed
Final Draft Report.

Appendix B

Intergovernmental Agreement
Between
The State Of Arizona
And
The USDA Forest Service, Southwestern Region, 1990.

Appendix C

303(d) Investigation Project Plan, Blue River.

Appendix D

FY 2001 Water Quality Sampling Data